

# Two New Species of the Genus *Caldukia* BURN & MILLER, 1969

(Mollusca : Gastropoda : Opisthobranchia)

from New Zealand Waters

BY

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(21 Text figures)

## INTRODUCTION

THE GENUS *Caldukia* BURN & MILLER, 1969 was established to embrace 3 species of janolid nudibranch, one Australian and two from New Zealand, which could not be placed in any of the known genera. *Caldukia* is distinguished from the other genera of the family JANOLIDAE (*Zephyrina* QUATREFAGES, 1844; *Janolus* BERGH, 1884; *Antiopella* HOYLE, 1902; a new genus (MILLER, in press) by the shape of the rhinophoral club (short and stout with a small series of primary lamellae, each with regularly disposed rows of secondaries), the lack of an inter-rhinophoral crest, a radula of the formula 6·1·6 with the lateral teeth strongly cuspidate, and very strong unequal jaws with a few large horny teeth. A fairly complete comparison of the genera has already been made (MARCUS, 1955, 1958; BURN & MILLER, 1969; MILLER, in press). The Australian species, which is the type of the genus, was first described a little over a decade ago and at that time was provisionally assigned to the genus *Proctonotus* ALDER & HANCOCK, 1844 (BURN, 1958); although the two New Zealand species were first discovered in 1961, original descriptions of them are only now being presented.

## ACKNOWLEDGMENTS

I wish to thank Professor J. E. Morton for advice and encouragement, Mr Robert Burn for discussing arminid systematics and nomenclature and for letting me examine his colour photograph of a living specimen of *Caldukia affinis*, Dr E. J. Batham for permitting me to use the Portobello Marine Biological Station and the University Grants Committee (New Zealand) for financing much of my field work.

## CLASSIFICATION

### NUDIBRANCHIA

#### Arminacea

#### PACHYGNATHA

#### JANOLIDAE

## DESCRIPTIONS

### *Caldukia albolineata* MILLER, spec. nov.

**Morphology:** Length, extended, 11 mm (only one specimen collected). Body soft, lanceolate in outline (anterior end blunt); low, back slightly arched with a large elliptical swelling, the pericardium, in the centre, which is confluent posteriorly with a prominent longitudinal ridge (the dorsal sinus) which runs part way to the anus (Figure 1). Rhinophores one-sixth to one-seventh of the length of the body; peduncle very short; club stout with 6 sloping primary lamellae (lamellae of the two sides of the rhinophore widely separate anteriorly, but approximate posteriorly), each with an upper and lower row of small plates arranged alternately, and the rachis is produced apically as a cylindrical truncate process about one-third of the height of the rhinophore (Figure 2). Oral tentacles are short, blunt triangular lobes. Cerata linear, apices pointed, non-caducous and very mobile (Figure 3); the largest, when extended, roughly one-fifth of the length of the body; inserted in 3 staggered longitudinal rows, cerata smallest at the edge of the notum, increase in size centripetally (Figure 4). Foot rounded at the front; tail short, tapers to a fine point. Anus at the tip of a large papilla situated in the mid-line near the

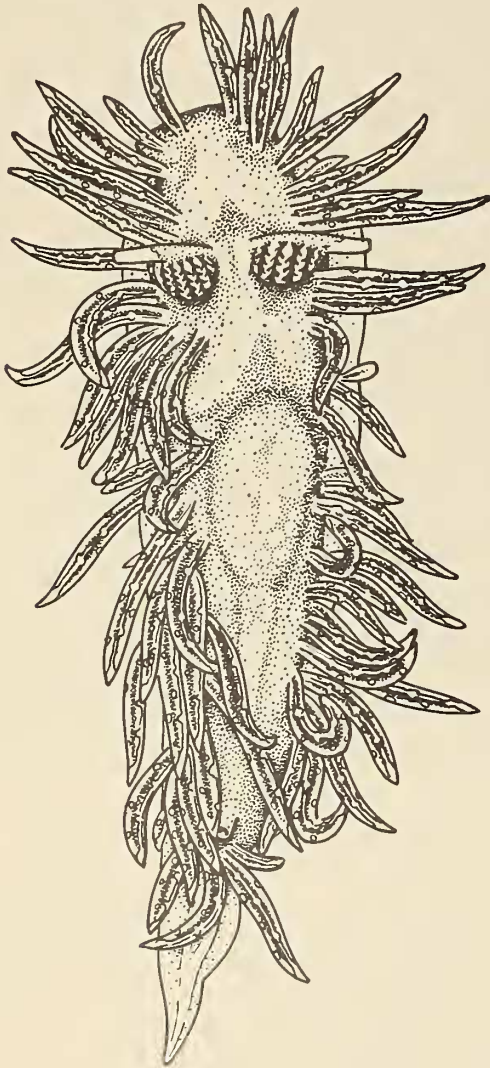


Figure 1

*Caldukia albolineata*

Dorsal view of the living animal

posterior end of the notum. Reproductive apertures on the right side, just below the edge of the notum at a level midway between the rhinophores and the front of the pericardium. Renal pore on the right side, just below the edge of the notum and at a little distance from the rear end of the pericardium (Figure 4).

**Colour:** Body translucent, pale dull yellow; hermaphrodite and female accessory glands show through as a central opaque mass. Rhinophores pale dull yellow, apical process covered with opaque white. Each ceras with a dark brown diverticulum, centre of inner surface with a narrow lumpy stripe of opaque white running from the base to the tip, flanked by fairly large spots of the same pigment (Figure 3). Dorsal surface of tail with a wedge-shaped patch of opaque white.

**Alimentary System:** Figure 5. Oral tube short and wide, leads to the massive, ovate (when viewed from above),



Figure 2

*Caldukia albolineata*

Side view of a rhinophore

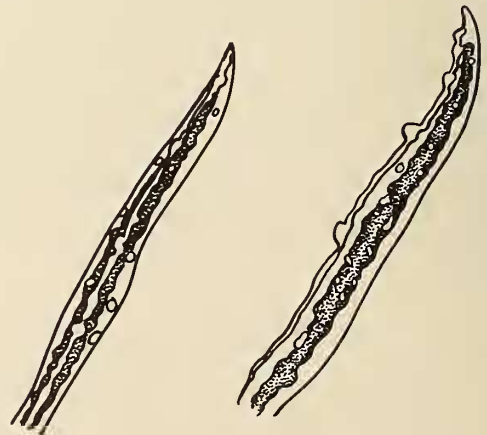


Figure 3

*Caldukia albolineata*

Cerata of the living animal: left – view of inner surface, right – view of lateral surface

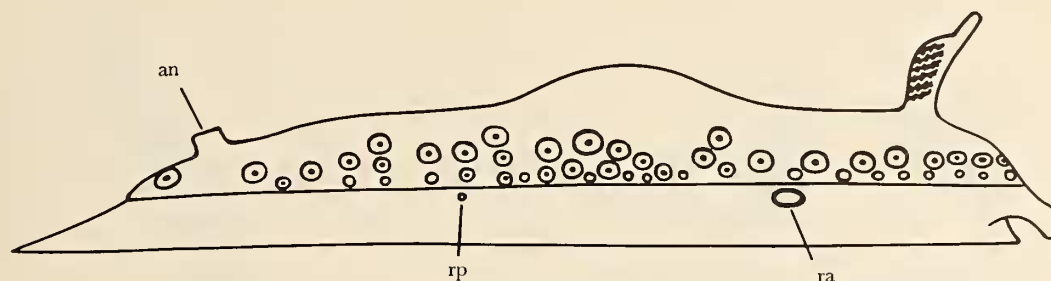


Figure 4

*Caldukia albolineata*View of the right side of the body showing the insertions  
of the cerata and the apertures

an = anus    rp = renal pore    ra = reproductive apertures

dorso-ventrally flattened buccal bulb. Salivary glands huge, folliculose, lie closely applied to the sides of the oesophagus and ventro-lateral walls of the stomach (in the one specimen examined the condition of the salivary glands was probably abnormal, the left gland extended behind the stomach along the main posterior duct of the digestive gland and ended at the origin of the second left lateral duct – the right gland was very small and barely reached the stomach). Oesophagus short, wide and muscular, runs from the centre of the upper surface of the buccal bulb to the fairly large banana-shaped muscular stomach which lies to the left of the mid-line. There are 3 main stomachal ducts of the digestive gland; the right and left anterior ducts are short and each opens into a wide longitudinal duct which extends along the edge of the anterior half of the notum on the left side and two-thirds on the right. Short lateral branches, simple and divided, arise along the sides of the longitudinal duct, a few on the inner side and many on the outer. The posterior duct, which shares a common opening into the stomach with the left anterior duct, is long; it runs along the left side of the gonad and then, just before the hind end of the pericardium, starts to bend over to the mid-line of the body, giving off as it does so, two lateral ducts to the left side. On reaching the mid-line, the main duct bends sharply, giving off as it does the first right lateral duct, to run posteriorly above the intestine, sending branches to the left side. It veers gradually to the left side of the anus and then curves to the right around the posterior end of the notum sending off short branches; all but the most posterior of the lateral ducts branch. Diverticula arise singly from the longitudinal ducts and side branches.

Each diverticulum is simple and extends almost to the tip of the ceras (Figure 6). The intestine arises on the left side from the posterior end of the stomach; it bends immediately through  $180^\circ$  and then describes a half circle around the front of the pericardium as it passes to the right side. On the right side the intestine continues to bend and passes below the posterior end of the pericardium to return to the left; it then bends again to run to the anus.

**Buccal Armature:** Radula (Figure 7). Formula  $6 \cdot 1 \cdot 6$ ; the one specimen examined had a radula of 28 (including 6 developing) rows. Central tooth smallish, roughly trapezoidal; posterior face concave, upper edge notched to form a broad semilunar median cusp with a small apical denticle; the notched edge is serrulate and there is a denticle on each of the corners. The lateral teeth are peg-like; the inner 5 (2 and 3 are the largest) are fairly similar in shape with a broad cuspidate crown, the middle cusp being very large, and a somewhat sinuous and slightly tapered base (short in 5) bent towards the margin of the radula; the sixth (the outermost) is very small, almost rectangular with a single (median) cusp. Jaws (Figure 8). Strong, unequal, united dorsally by a thick band of chitin. Right jaw long, fairly narrow and curved with 4 large horny teeth at the anterior end. Left slightly shorter than the right, but broader and angular, with 2 large teeth.

**Nervous System:** Although worked out in some detail it is not described here: the most important features are the long optic nerves and the fused cerebral and pleural ganglia.



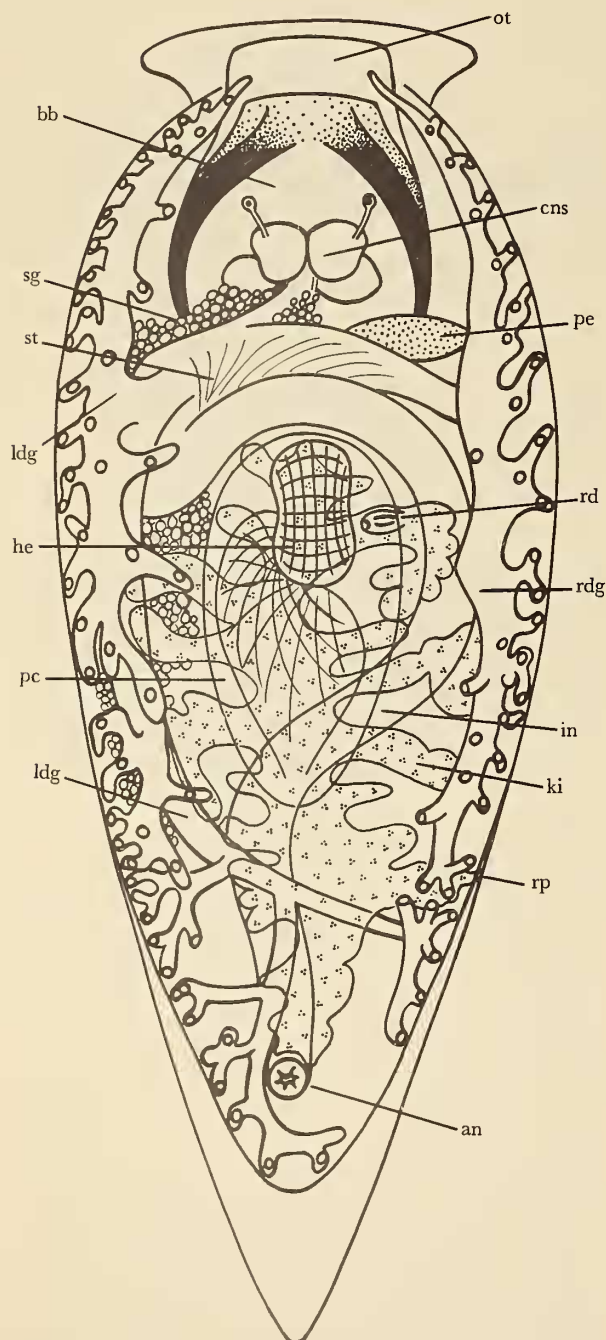


Figure 6

*Caldukia albolineata*

Preserved ceras (stained with borax carmine and cleared with cedar-wood oil) showing diverticulum of digestive gland

**Kidney:** Figure 5. This organ lies dorsally between the front end of the pericardium and the anus: it is thin walled and consists of a long central sac and a number of lateral diverticula, some reaching almost to the edge of the notum; the anterior diverticula are long and irregularly lobed, those to the posterior are short and simple. The renopericardial duct (organ) is small and

Figure 5

(← adjacent column)

*Caldukia albolineata*

Dorsal view of the general anatomy

an = anus    bb = buccal bulb    cms = central nervous system  
 he = heart    in = intestine    ki = kidney  
 ldg = left digestive gland    ot = oral tube    pc = pericardium  
 pe = penis    rd = renopericardial duct  
 rdg = right digestive gland    rp = renal pore  
 sg = salivary gland    st = stomach

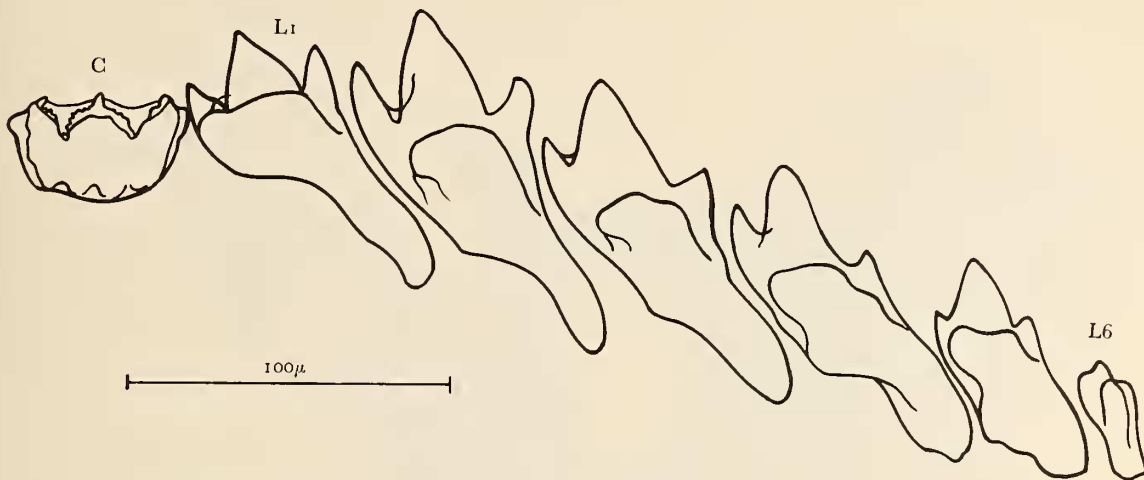


Figure 7

*Caldukia albolineata*

Radular teeth, half row

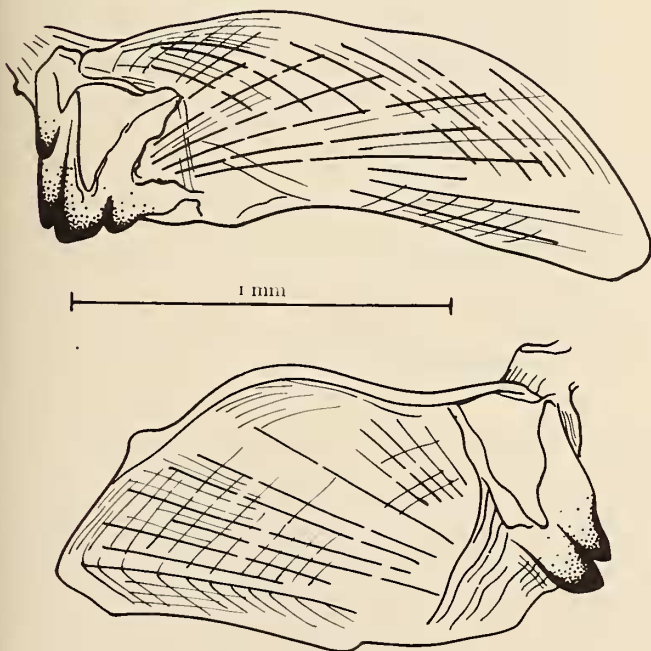
C = central (rhachidian)      L1 = innermost lateral  
L6 = outermost lateral

Figure 8

*Caldukia albolineata*

Jaws, view of inner surface

upper - right jaw

lower - left jaw

links the pericardium with the first large right diverticulum. The renal pore opens at the tip of the last large right diverticulum.

**Reproductive System:** Figure 9. Hermaphrodite gland of 4 follicles, each joins separately, by a long ductule, to the common hermaphroditic duct which runs forward to the ampulla. The ampulla is ovoidal with a small chamber (or pouch) on the right side into which opens the hermaphrodite duct and, by a short narrow duct, a small vesicle (the fertilization chamber). The vas deferens and oviduct arise separately, the former from the front end of the ampulla, the latter from the front end of the side chamber. The first third of the vas deferens is a narrow duct, the remainder is a very wide glandular portion (the prostate); the penis is conical and unarmed (Figure 10). The oviduct runs to the right, constricts and then forks, one of the branches leads to the albumen gland, the other to the female atrium. The bursa copulatrix is ovoid and is connected to the atrium by a long narrow duct, the vagina.

**Locality and Habitat:** New Zealand, the South Island: Otago Harbour, Aquarium Point, one specimen on the under surface of a rock in the sublittoral fringe, 20 January 1961.

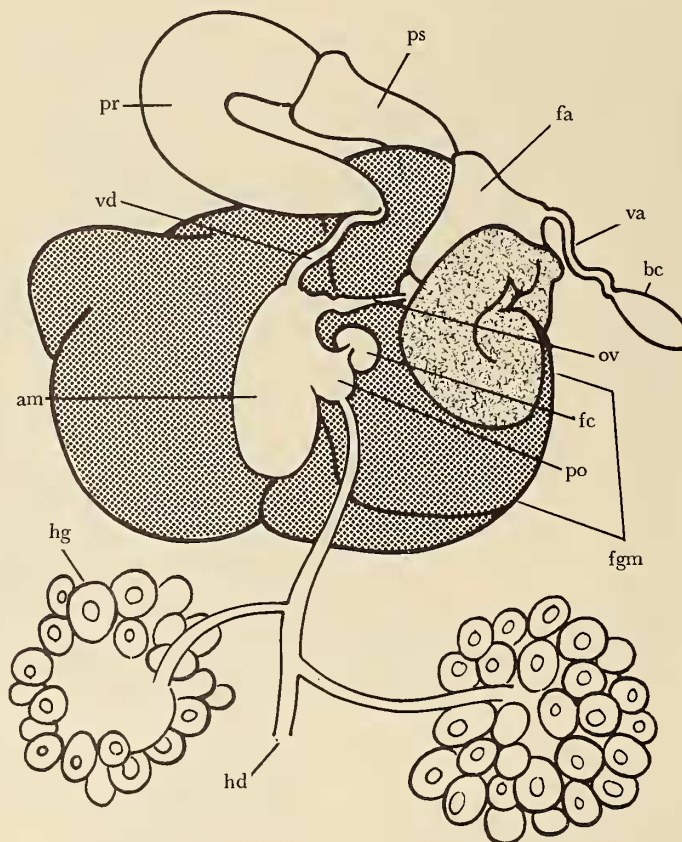


Figure 9

*Caldukia albolineata*

## Reproductive system, unraveled

am = ampulla    bc = bursa copulatrix    fa = female atrium  
 fc = fertilization chamber    fgm = female gland mass  
 hd = hermaphrodite duct    hg = hermaphrodite gland  
 ov = oviduct    po = pouch    pr = prostate  
 ps = penial sheath    va = vagina    vd = vas deferens

**Type:** Holotype – a microscope slide of the radula and a colour photograph (35 mm Kodachrome transparency) of the one living animal collected at Aquarium Point, deposited in the Dominion Museum, Wellington (M. 22177).

*Caldukia rubiginosa* MILLER, spec. nov.

**Morphology:** Figure 11. Extended length up to 12 mm. As the previous species except for the following details: rhinophores with up to 7 lamellae, lowest very small (Fig-

ure 12); cerata fusiform (Figures 13, 14), in up to 4 rows. **Colour:** Dorsal part of the body, rhinophores, distal portion of cerata, opaque reddish brown; cerata transparent (except at base), upper half yellow, lower half colourless, latter divided by a band of opaque white (with blue iridescence) which is broad to the centre of the body and narrow to the outside, diverticula apricot or pale brown; upper region of the side of the foot speckled with reddish brown, lower region, tail and sole transparent yellow or apricot – hermaphrodite gland visible as opaque pink bodies.

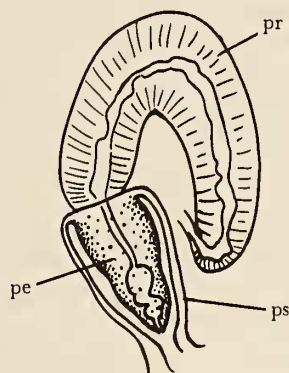


Figure 10

*Caldukia albolineata*

Penis, preserved (stained with borax carmine, cleared in cedar-wood oil)

pe = penis      ps = penial sheath      pr = prostate

**Alimentary System:** As *Caldukia albolineata* spec. nov. There is, however, a right post-anal branch of the digestive gland.

**Buccal Armature:** Radula (Figure 15). A 9 mm animal had a radular formula of 23 (including 5 developing rows)  $\times 6 \cdot 1 \cdot 6$ . Teeth very similar to those of *C. albolineata*: central with weak serrulations, central cusp without an apical denticle, no denticles at the corners; laterals rather uneven in outline, inner 4 teeth with a small flange developed on both the inner and outer sides of the central cusp. Jaws (Figure 16): as in *C. albolineata*, but the right jaw is slightly more angular.

**Kidney:** Large, filling the dorsal region of the body cavity from the middle of the pericardium to the anus. More branched than in *C. albolineata* and the branches are so compacted as to give the organ an alveolate appearance.

**Reproductive System:** Figures 17, 18. Very similar in plan to that of *Caldukia albolineata*. However, the ampulla is oblong, the hermaphrodite duct does not enter by way of a lateral swelling and there is no vesicle (fertilization chamber) at the side; also, a short, narrow, common duct leaves the front end of the ampulla and this bifurcates into vas deferens and oviduct.

**Locality and Habitat:** New Zealand, the North Island: Goat Island Bay, near Leigh; on the under surfaces of rocks in the sublittoral fringe, feeding on the polyzoan



Figure 11

*Caldukia rubiginosa*

Dorsal view of a living animal

*Beania magellanica* (Busk); six specimens, one spawn band, 28 August 1961; two specimens, several spawn bands, 26 October 1961; two specimens, 26 February 1963.





Figure 12

*Caldukia rubiginosa*

Side view of a rhinophore

**Type:** Holotype: a specimen collected at Goat Island Bay, near Leigh, deposited in the Dominion Museum, Wellington, New Zealand (M. 22178).

**Food and Feeding Habits:** *Caldukia rubiginosa* feeds on the polyzoan *Beania magellanica* (BUSK) which it tears apart with its large, strong dentate jaws. A single zooid is attacked – this and adjacent zooids are first smothered with mucus. When feeding, the mouth is opened wide and the buccal bulb thrust forward so that the jaws and radula are protruded (Figure 20). Jaw and radular movements are synchronized with those of the buccal bulb; when the latter is thrust forward the jaws and the two halves of the radula open, when withdrawn, they close. The polyzoan zoecium, which is usually grasped about the middle, is fractured by the large horny teeth

<sup>1</sup> Mentioned briefly in MORTON & MILLER (1968) on p. 412 but the species is not named



Figure 13

*Caldukia rubiginosa*

Cerata of a living animal; left drawing shows pigmentation and diverticulum of the digestive gland



Figure 14

*Caldukia rubiginosa*

Preserved ceras (stained with borax carmine and cleared with cedar-wood oil) showing diverticulum of the digestive gland

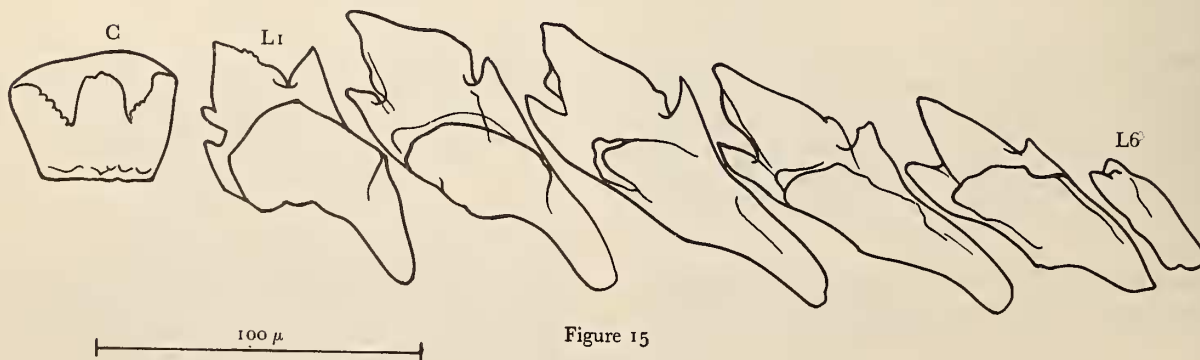


Figure 15

*Caldukia rubiginosa*

Radular teeth, half row

C = central (rachidian) L1 = innermost lateral

L6 = outermost lateral



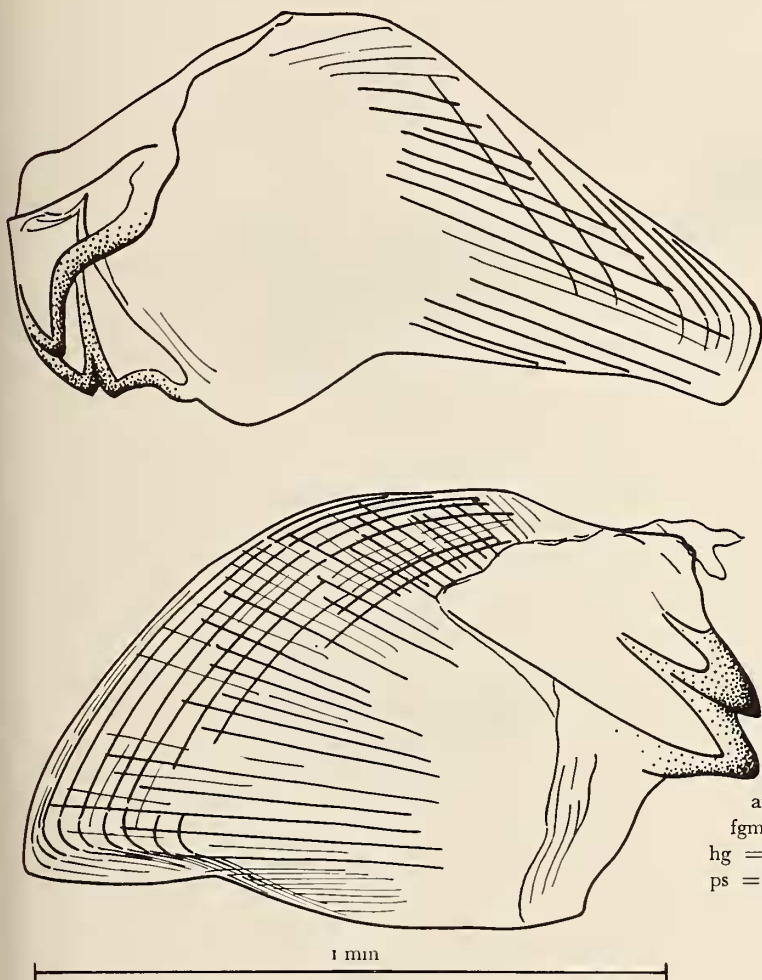


Figure 16

*Caldukia rubiginosa*

Jaws, view of inner surface  
upper - right jaw      lower - left jaw

of the jaws closing upon it and drawing it into the buccal cavity, assisted by a sharp contraction of the head on the firmly fixed foot. This is repeated many times until the zooid, or part of it, is torn from the colony (Figure 21). The polypide is completely macerated during the tearing process. The radula acts as a conveyor belt and transports the detached zooid, or fragment, to the oesophagus. The whole action is very rhythmical, there being an active phase of 10 - 25 seconds during which the animal makes 4 to 8 thrusts with its buccal mass, followed by a resting phase of 60 - 70 seconds. The nudibranch may take up to 35 minutes to detach a single zooid. The zoöcia of the zooids ingested are not altered as they pass through the

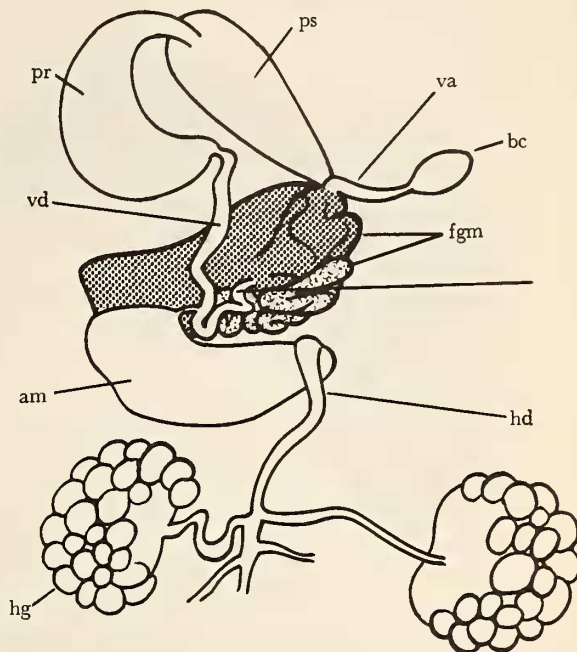


Figure 17

*Caldukia rubiginosa*

Reproductive system, untraveled

am = ampulla      bc = bursa copulatrix  
fgm = female gland mass      hd = hermaphrodite duct  
hg = hermaphrodite gland      ov = oviduct      pr = prostate  
ps = penial sheath      va = vagina      vd = vas deferens

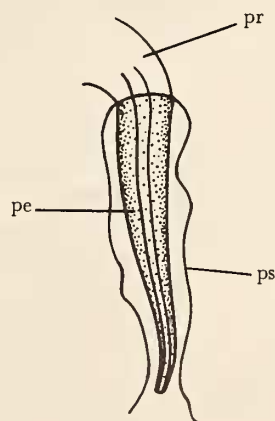


Figure 18

*Caldukia rubiginosa*

Penis, preserved (stained with borax carmine, cleared in cedar-wood oil)

pe = penis      ps = penial sheath      pr = prostate

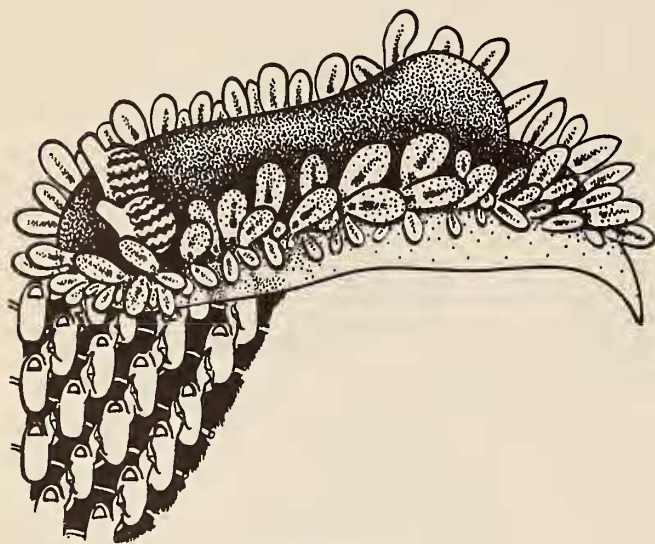


Figure 19

*Caldukia rubiginosa*

Drawing of an animal feeding on the polyzoan  
*Beania magellanica* (Busk)

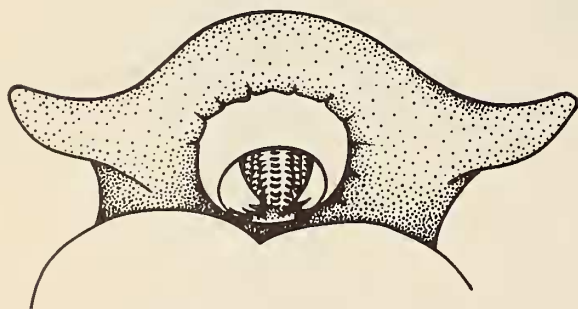


Figure 20

*Caldukia rubiginosa*

Ventral view of the head of a living animal showing the buccal bulb thrust through the dilated mouth and the jaws and two halves of radula opened

gut; they are, however, compacted into a firm string before being defaecated.

## DISCUSSION

Colour and colour pattern clearly distinguish the two species of *Caldukia*, described here, from each other and

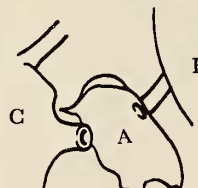


Figure 21

*Caldukia rubiginosa*

Series of sketches showing an animal (head only shown) biting off a single zooid of *Beania magellanica* (Busk).

Bottom - a ventral view of head with an avicularium (bitten off with the zooid) protruding from the mouth. A, B, C - letters identifying the zooids

from the type species, *C. affinis* (BURN). Briefly stated: *C. rubiginosa* has a reddish brown body and cerata with colourless, yellow and opaque white (blue iridescence) zones; *C. albolineata* has a dull yellow body and a single opaque white line down each ceras; and *C. affinis* has a reddish fawn body marked mid-dorsally with yellow and fawn cerata speckled with minute red spots. The colours and patterns appear to be constant in *C. rubiginosa* and *C. affinis*. There are only minor morphological and anatomical differences between the three species. Most important of these is the shape of the radular teeth, particularly the central and the first and sixth laterals. In *C. albolineata* the central is broad with a wide median cusp, which, like the corners, is apiculate and serrulate. This tooth in *C. rubiginosa* differs in being longer (when viewed from above) and without the denticles on the cusp and the corners (though these may have been worn off in the animal examined). *Caldukia affinis* has a central tooth with a narrow blunt cusp and no denticles or serrulations. The first lateral tooth of *C. affinis* is almost rectangular, but in the other two species it has a comma-shaped base (like lateral teeth 2 to 5 of all 3 species); the median cusps of the first to fourth lateral teeth of *C. rubiginosa* have small side flanges. The sixth tooth of *C. affinis* has a fairly long, pointed and bent base, whereas in the other 2 species it is very short and blunt. The jaws differ only slightly in outline. In the few specimens examined there were minor variations in the branching of the digestive gland, but these did not appear to be constant enough to be used to separate the species. The reproductive system is fundamentally similar in the 3 species; however, that of *C. albolineata* differs from the systems of the other 2 species in the following 2 respects: (1) the male and female ducts leave the ampulla separately, i. e., there is no anterior common duct, and (2) the fertilization chamber is a vesicle at the side of the ampulla.

## SUMMARY

Two new species of the janolid nudibranch genus *Caldukia* BURN & MILLER are described, viz. *C. albolineata* and *C. rubiginosa*. The anatomy of *C. albolineata* is given in some detail and the feeding habits of *C. rubiginosa*, which preys on the polyzoan *Beania magellanica* (BUSK), are briefly described. The two new species and the type of the genus, *C. affinis* (BURN) are compared; colour and pattern are the principal distinguishing characteristics; small differences in the radular teeth and reproductive system are of secondary importance.

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